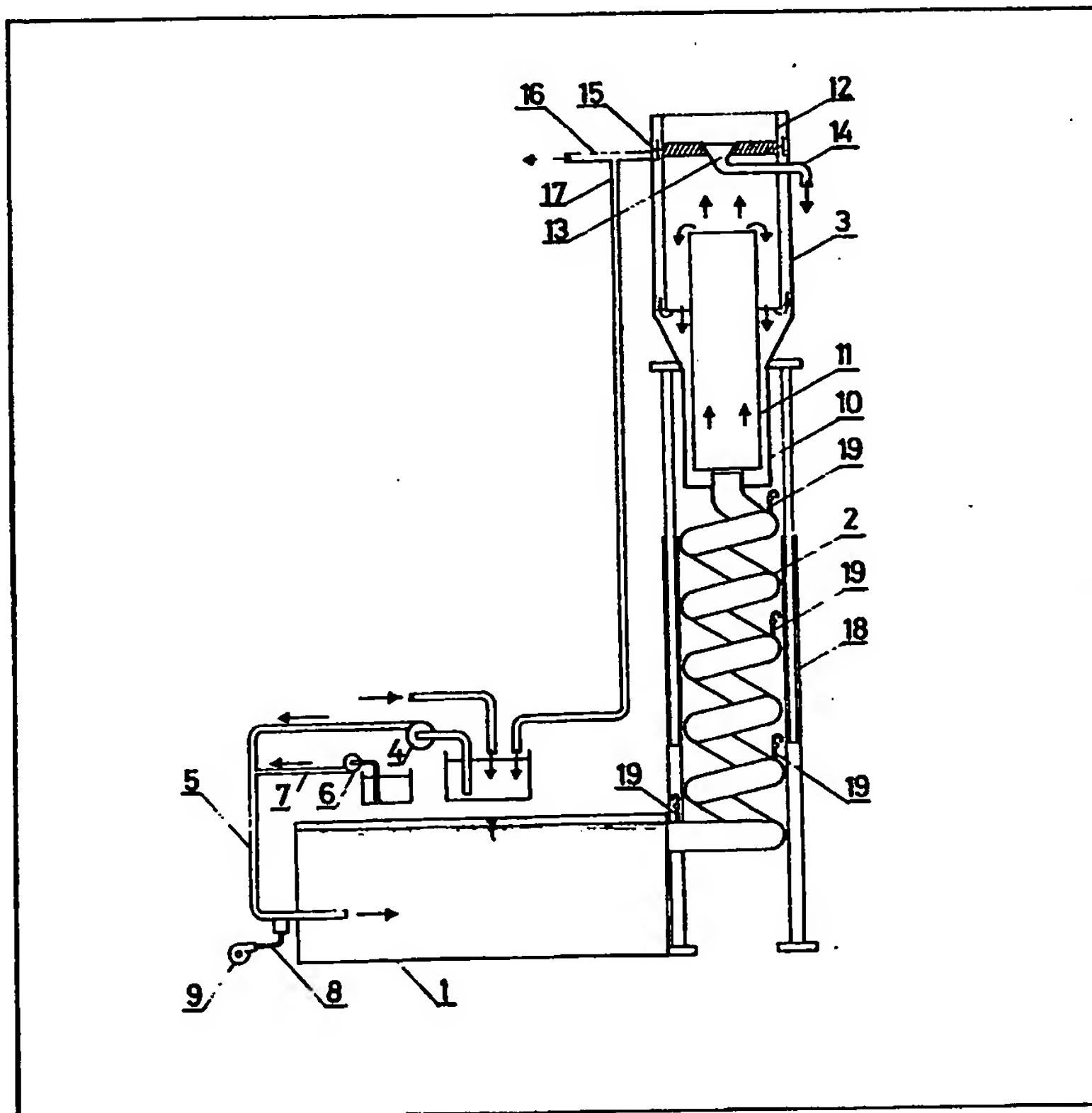


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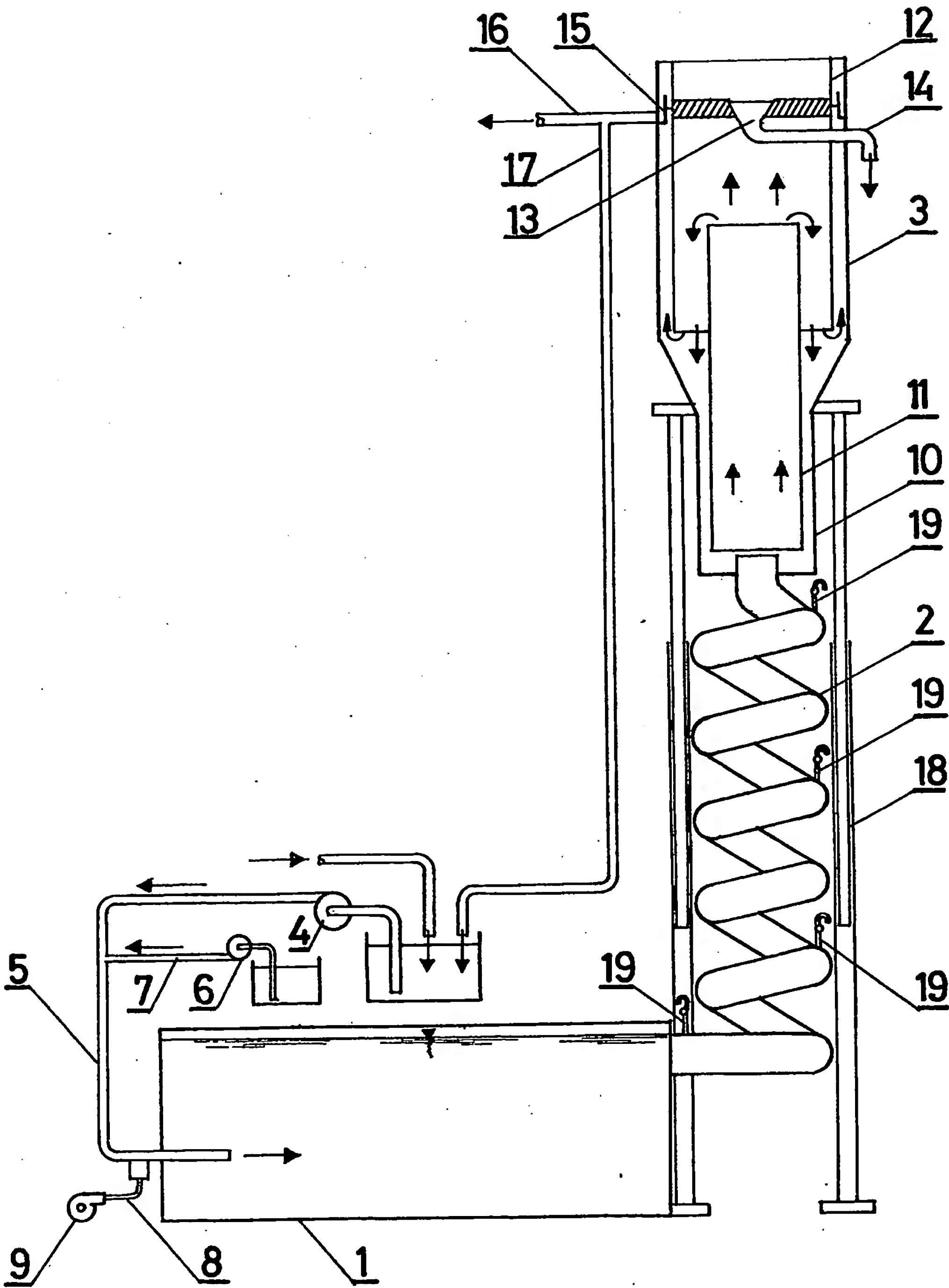
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(54) Method and apparatus for treat-  
 ing water and other liquids

(57) In an apparatus for treating con-  
 taminated liquid comprising a flotation  
 tank 3 adjustably mounted above a  
 saturation chamber 1 and connected  
 thereto by a spiral conduit 2, coagulant  
 is added to the contaminated liquid and  
 the latter is saturated with air, in the  
 saturation chamber, under a predeter-  
 mined pressure and for a predeter-  
 mined time, the liquid then flows slowly  
 through the conduit 2 under conditions  
 which promote agglomeration of the  
 contaminants and simultaneously the  
 pressure of the liquid is reduced so that  
 microbubbles of air adhere to the  
 agglomerating contaminants causing  
 them to float to the surface of the tank 3  
 within the cylinder 12.



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## SPECIFICATION

### Method and apparatus for treating water and other liquids

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The present invention relates to the treatment of water and other liquids and, more particularly, to a method and apparatus for conditioning water and treating sewage and polluted water, especially such liquids containing greasy and oily substances, by coagulation and gas flotation, primarily air flotation. It is directed to the removal from water and sewage of various kinds of contamination, particularly suspensions, colloids, emulsions or chemically precipitable ingredients and soluble contaminants. The invention also provides for concentrating hydrated sediments.

Known methods for conditioning water, for treating sewage and polluted water and for concentrating sediments by coagulation and flotation rely upon the separate functioning of particular component operations. The process of coagulation occurs in two steps: in the first step coagulant is added to the contaminated liquid and stirred vigorously, and in the second step the liquid and coagulant are mixed slowly. During this period flocculation or agglomeration occurs, i.e. initially formed flocules or nuclei grow and particles in suspension and colloidal particles are adsorbed onto them. The process of flotation also involves two steps: initially the liquid is saturated with air under pressure, and then it is fed through a pressure reducing valve to a flotation tank where, as a result of the sudden change in pressure, gas bubbles are liberated from the liquid and carry away contaminants. The disadvantage of such a method of producing flotation is the fact that large-size air bubbles are formed which cause turbulence in the flotation tank which, in turn, adversely influences the removal of agglomerations of contaminants. These factors reduce the effectiveness of the treatment. Instead, a negative side of the whole multi-stage process is the necessity to synchronise subsequent operations, then controlling each step.

A method of purifying water by flotation is additionally known from Polish Patent Specification No. 77428 in which liquid to be purified, together with coagulant and air, is introduced into a saturation chamber, in which the mixture remains for at least three minutes, and is then fed without change of pressure to a flotation column, where the hydrostatic pressure of the liquid decreases as the liquid flows to the top of the column. The effect of this is the continuous liberation of air bubbles which cohere with previously formed suspensions and carry them to the surface.

Known coagulation and flotation installations used for water conditioning, sewage treatment and concentrating sediments comprise single-function units operating as in-line system in the sequence, coagulation followed by flotation. Installations for coagulation have mixing and agglomeration tanks and are supplied with special mechanical appliances for regulating the processes of vigorous and slow mixing. Installations for flotation comprise satura-

tion chambers and flotation tanks. Between each chamber and tank the pressure reducing valve is installed for causing rapid change of pressure in the liquid and, hence, liberation of air bubbles which carry away the contaminants.

The disadvantage of such assemblies is the necessity for separate maintenance for each of them, and simultaneous synchronisation of the running operations.

Polish Patent Specification No. 77428 discloses an installation for the purification of liquids, especially water, by flotation. This installation comprises a flotation tank in the form of a column filled with the liquid, inside which column, at its lower part, the saturation chamber is submerged. The liquid to be purified is introduced to the saturation chamber, together with a coagulant, by a pipe to which another pipe is connected via which gas is supplied. In the saturation chamber, there occurs the process of dissolution of gas in the liquid in an amount dependent on the height of the column of liquid in the flotation tank, and excess gas is returned by a pipe connected to the column. Simultaneously coagulant is intimately mixed with the liquid, causing a flocculant precipitant secretion from the liquid. Saturated liquid flows from the saturation chamber, through openings, to the body of liquid which is present in the flotation tank, and the flow proceeds without significant change of pressure in relation to the pressure in the chamber. As the liquid flows to the top of the column, the hydrostatic pressure in the liquid decreases and, hence, large amounts of tiny air bubbles are liberated from the liquid and adhere to resulting flocules in suspension. The flotation tank has, at its upper part, an increased diameter with outlet troughs for clarified water and floating contaminants.

The present invention consists in a method of treating contaminated water or other liquid by coagulation and gas flotation, comprising subjecting the contaminated liquid simultaneously to coagulating, or polyelectrolytes dissolving, and gas saturation steps under conditions of substantially complete mixing and circulation at a pressure of at least 0.5 atms and for a time of at least two minutes, and subjecting the liquid, under conditions of slow and controlled flow which favour agglomeration of the contaminants, simultaneous to slow depressurisation and agglomeration for a time of at least one minute, whereupon micro-bubbles of gas are formed inside and about the agglomerating contaminants forming floating deposits on the surface of treated liquid.

The steps of mixing the liquid with chemical coagulants and saturation may be effected in the lower part of a column of the liquid, where the pressure is greatest, whilst the steps of agglomeration and depressurisation may take place in a zone extending from the lower to the upper part of the column, where the pressure continuously decreases, and the steps of separating and collecting the floating contaminants may take place in the upper part of the column, where the pressure is the lowest. The steps of mixing with coagulant and saturation, as well as depressurisation and agglomeration may

proceed continuously during liquid flow from the bottom to the top of the column, and the parameters of the method are controlled by changing the height of the liquid column, i.e. the amount of pressure, the direction of the process, and the degree of recirculation of clarified liquid, i.e. the degree of dilution of the polluted liquid.

The present invention also consists in apparatus for treating contaminated water or other liquid by coagulation and gas flotation, comprising a flotation tank and a saturation chamber, said saturation chamber being disposed below the flotation tank and being connected thereto by an agglomeration and depressurisation conduit through which the liquid flows whilst agglomeration occurs and the liquid pressure is simultaneously reduced, and said flotation tank having a lower cylinder disposed substantially symmetrically in its lower part, an upper cylinder projecting between the wall of the flotation tank and the wall of the lower cylinder, a first overflow adjacent the rim of the flotation tank for the outlet of clarified liquid, and a second overflow within the upper cylinder for the removal of floating contaminants.

A pump may be connected to the saturation chamber at its lower part for supplying liquid and sediment to be treated to the chamber. The output conduit of the pump may additionally be connected with the feed for the flotation agent or coagulant and with an air line.

Advantageously, the flotation tank has, at its lower part, a cylindrical elongation in which the lower cylinder is disposed without touching the bottom of the tank.

Preferably, the agglomeration and depressurisation conduit is of a spiral, sinusoidal or other serpentine configuration and is made from resilient material or in segments so as to be adjustable in length. This conduit may be disposed vertically or at a small angle. The height of the flotation tank above the saturation chamber is preferably adjustable and is at least five metres.

The first overflow by which clarified liquid is removed may be connected by recirculation conduit with a tank containing the liquid to be treated. Disposed along the agglomeration and depressurisation conduit may be vent valves for bleeding off excess air.

The invention provides a liquid treatment method which is very effective due to the production of micro-bubbles of air in the region of the agglomerating contaminants. The bubbles of air are very fine and are liberated very slowly without disturbing the process of agglomeration. Furthermore, the invention provides a treatment apparatus which is a multi-purpose appliance for simultaneously conducting the processes of coagulation and flotation and which is applicable to the field of sediment concentration, as well as to water conditioning and sewage treatment. It is of simple design and cheap to manufacture.

In order that the invention may be more readily understood, reference will now be made to the accompanying drawing which illustrates a plant suitable for water conditioning, sewage and polluted

water treatment or concentrating sediments.

Referring to the drawing, the plant comprises a saturation chamber 1, connected by an agglomeration and depressurisation pipe or conduit 2 to a flotation tank 3 mounted above the saturation chamber. Connected to the saturation chamber 1, adjacent its bottom, is the outlet conduit 5 of a pump 4 for supplying unclarified water, sewage or a liquid suspension of sediment to the saturation chamber.

The conduit 5 is connected to the outlet conduit 7 of a pump 6 which feeds a flotation agent or coagulant to the chamber. The conduit 5 is also connected with the outlet 8 of a compressor 9 for supplying compressed air to the chamber 1.

The flotation tank 3 is in the form of a vertical cylinder having its lower part shaped as cylindrical elongation 10 with a diameter smaller than the diameter of the upper part of the tank. Disposed in this elongation and also in the upper part of the tank, is a lower cylinder 11 which depends coaxially in such a manner as not to touch the bottom of the tank. Mounted in the upper part of the tank 1 is an upper cylinder 12 which extends downwardly and surrounds an upper end portion of the lower cylinder 11. The diameters of the various parts of the tank and the cylinders are selected so as to ensure sufficient clearance between them to permit ready flow of liquid.

Disposed inside the cylinder 12, at its upper part, is an overflow funnel 13 which is connected to an outlet conduit 14 via which floating contaminants are removed. Disposed inside the flotation tank, adjacent its rim, is an overflow trough 15 for removing clarified liquid. The trough 15 is connected to an outlet 16 and to recirculating conduit 17, which directs clarified liquid to a tank containing untreated liquid for diluting the latter.

The conduit 2 is made from resilient material and has a spiral or helical configuration which is adjustable in length. The flotation tank 3 is installed on a supporting structure 18 of adjustable height. Connected to the conduit 2 are vent valves 19 which vent excess gas from the conduit.

## 110 CLAIMS

1. A method of treating contaminated water or other liquid by coagulation and gas flotation, comprising subjecting the contaminated liquid simultaneously to coagulating, or polyelectrolytes dissolving, and gas saturation steps under conditions of substantially complete mixing and circulation at a pressure of at least 0.5 atms and for a time of at least two minutes, and subjecting the liquid, under conditions of slow and controlled flow which favour agglomeration of the contaminants, simultaneous to slow depressurisation and agglomeration for a time of at least one minute, whereupon micro-bubbles of gas are formed inside and about the agglomerating contaminants forming floating deposits on the surface of treated liquid.

2. A method as claimed in claim 1, wherein the steps of mixing the liquid with coagulant and saturation are effected in the lower part of a column of the liquid, where the pressure is greatest, the



steps of agglomeration and depressurisation take place in a zone extending from the lower to the upper part of the column, where the pressure continuously decreases, and the steps of separating and collecting the floating contaminants takes place in the upper part of the column, where the pressure is lowest.

3. A method as claimed in claim 1, wherein the steps of mixing with coagulant and saturation, as well as depressurisation and agglomeration, occur continuously during liquid flow to the top of the column, and the parameters of the method are controlled by the height of the column, that is, the value of the pressure, the duration of the method, and the degree of recirculation of clarified liquid, that is, the degree of dilution of the contaminated liquid.

4. Apparatus for treating contaminated water or other liquid by coagulation and gas flotation, comprising a flotation tank and a saturation chamber, said saturation chamber being disposed below the flotation tank and being connected thereto by an agglomeration and depressurisation conduit through which the liquid flows whilst agglomeration occurs and the liquid pressure is simultaneously reduced, and said flotation tank having a lower cylinder disposed substantially symmetrically in its lower part, an upper cylinder projecting between the wall of the flotation tank and the wall of the lower cylinder, a first overflow adjacent the rim of the flotation tank for the outlet of clarified liquid, and a second overflow within the upper cylinder for the removal of floating contaminants.

5. Apparatus as claimed in claim 4, wherein the agglomeration and depressurisation conduit is of spiral or serpentine configuration and is made from resilient material or in segments so as to be adjustable in length.

6. Apparatus as claimed in claim 4 or 5, wherein the height of the flotation tank relative to the saturation chamber is adjustable and said height is at least five metres.

7. Apparatus as claimed in claim 4, 5 or 6, wherein the first overflow is connected by a recirculating conduit to a tank containing liquid to be treated.

8. Apparatus as claimed in claim 4, 5, 6 or 7, wherein the agglomeration and depressurisation conduit includes vent valves.

9. Apparatus as claimed in claim 4, 5, 6, 7 or 8, wherein the flotation tank has, at its lower part, a cylindrical elongation in which the lower cylinder is symmetrically disposed without touching the bottom of the flotation tank, and said cylinder, at its upper part, is surrounded by the upper cylinder, which allows liquid flowing within the flotation tank to recirculate.

10. Apparatus for treating contaminated water or other liquid, constructed substantially as hereinbefore described with reference to the accompanying drawings.

11. A method of treating contaminated water or other liquid, substantially as hereinbefore described with reference to the accompanying drawings.